National Aeronautics and
Space Administration
Ames Research Center

Educational Product	
Educators	Grades 3-5

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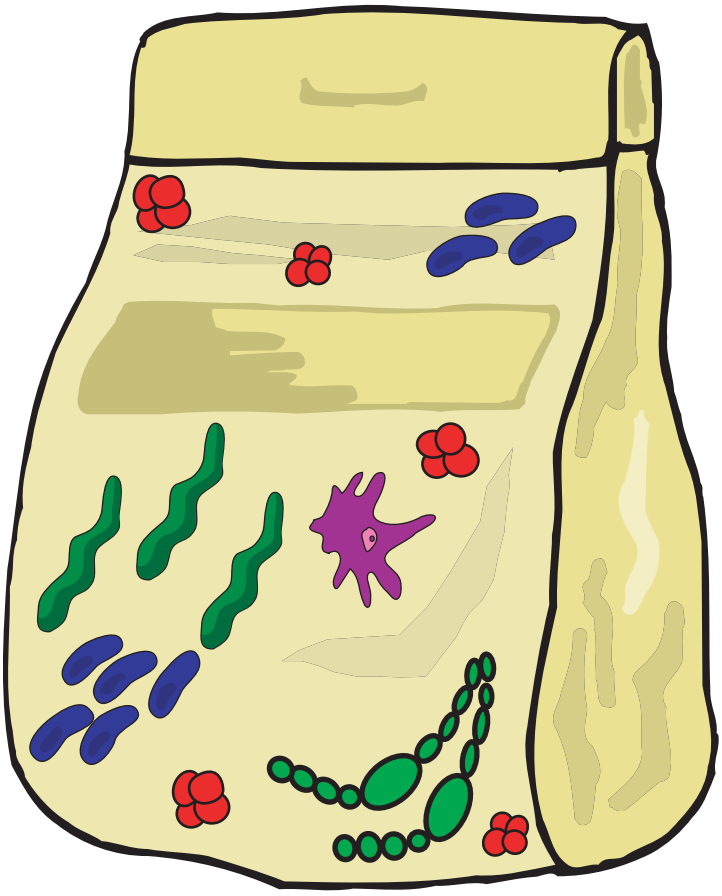
Growing Microbes in a Bag

An Educator Guide with Activities in Astrobiology



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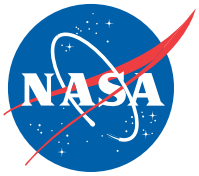
NASA Quest:
Growing Microbes in a Bag



National Aeronautics and Space Administration
Office of Education

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Growing Microbes in a Bag

Students will conduct their own investigation in which they grow microbes in a bag. Students will make observations and form explanations during the investigation. They will compare and contrast their methods during the investigation with those of the astrobiologists performing research in the field and the laboratory.

Goal: Students will perform an investigation and compare their methods with scientists.

Educational Objectives and Standards

Educational Objectives	National Education Standards/Benchmarks	Evaluation of Objectives
1. Students will conduct their own field investigation that will involve making observations and forming explanations about microbes.	**Meets**: NSES A1 Benchmarks 1B (3-5) 1, 1B (6-8) 1 ISTE 3, 4, 5 **Addresses**: NSES A2 Benchmarks 1B (3-5) 2, 1B (3-5) 3, 1B (6-8) 3 ISTE 6	• Record information for each step of the investigation in the Lab Journal. See Lesson (need to link)
2. Students will compare and contrast their methods with those of the astrobiologists.	**Meets**: Benchmarks 1B (3-5) 1, 1B (6-8) 1 ISTE 3, 4, 5 **Addresses**: NSES A1, A2 ISTE 6	• Create a Venn diagram comparing and contrasting the methods they used during the investigation with those used by the astrobiologists. See Lesson (need to link)

Prerequisite Knowledge

Prerequisite Concepts	Resources
Living thing: A living thing requires materials such as energy and nutrients, grows, and makes more of itself.	**Activity**: Point out or show students ten items. Include some living and some non-living things, such as a classmate, computer, pencil, plant, mushroom, or class pet. Ask the students to decide whether each item shown is living or non-living. Once all items have been discussed, ask the students to think about the qualities that they can use in the future to determine if something is living.
Opinion: An idea one believes to be true, but that is not based on evidence. **vs. Fact**: Information that is true, based on evidence.	**Activity**: Show students a book that they have recently read. Ask them to describe what they thought of the book. Explain that these thoughts are opinions because they are not based on measurable evidence, and one student' s thought on the book may differ from another student' s. Next have a student volunteer measure the length of the book and have a second volunteer measure the length of the same book. The measurements should be exactly the same, although human error may make them slightly differ. Explain to the students that the length of the book is a fact because it can be proven or measured with consistent results.
Observation: Using some or all of the five senses to make a factual and detailed description.	**Activity**: Show students an object. Ask them to describe the object using some or all of their five senses. Explain to them that their descriptions must be factual and detailed. Repeat this activity with numerous objects.

Suggested Schedule

(see calendar)

Materials

For Engage Activities:

- Mushroom or bread with mold to use as an example of a microbe
- Magnifying glasses to use on nature walk (optional)
- Class set of paper and pen/pencil

For Microbes in a Bag: (materials for one bag)

- 1/4-inch slice of fresh potato or 1-inch piece of bread without preservatives
- 1 resealable plastic sandwich bag
- 1 teaspoon of water
- 1/4 teaspoon of table sugar
- 1 spoon (measuring spoons if possible)
- 1 magnifying glass (optional)
- Lab Journal without procedures included or Lab Journal with procedures included (1 for each student in the group)

For Evaluation:

- Class set of paper or poster board for Venn diagram
- Class set of Scientific Inquiry Evaluation Rubric (for lab journals)
- Class set of Scientific Inquiry Evaluation Rubric (for student-designed experiments)
- Class set of Generic Rubric (for Compare/Contrast activity)

Equipment:

- Overhead projector, blackboard, or chart paper
- Computers with Internet browser and connection
- Optional Equipment:
- LCD panel or TV monitor connected to a computer with a video card
- E-mail account

Facilities:

- Classroom
- Computer lab (optional)

Preparation:

- Run a class set of Chat Question Generator.

- Preview NASA Web sites to make sure they work and are appropriate for your students.

- Locate the resources relevant to this event. These resources can include career fact sheets, biographies, and journals on the scientists participating in the webcast. If students won't be able to access these resources on the computer, print out copies of them.
  Link to webcast bios:
  http://quest.arc.nasa.gov/astrobiology/events/fieldwork/ed.html#profiles

Preparation (continued):

- If you are participating in a webcast, chat, or forum, follow the directions for Participating in a Webcast, Downloading RealPlayer, or Participating in a Chat.
- Note: Many districts have blocks to all chat lines on the Internet. Exploration of the Web site will help determine unexpected blocks of NASA Quest sites because of supposed access to online chatting that does not adequately screen out offensive language. If a block is found, it is up to you to attempt to get the site(s) unblocked. Follow your district's guidelines for unblocking a Web site. NASA Quest chats are moderated by an adult, so no inappropriate language is posted. Also, no personally identifying information is posted (i.e., e-mail, phone number).
- Check the Schedule to determine when the webcast is scheduled and if your class can attend at that time.

Common Misconceptions	Suggestions to help challenge these
A common misconception that students have is that microbes are not living things.	Discuss with students the needs of microbes and the needs of humans. The basic needs for both are the same: water, nutrients, and energy.
Students tend to look for or accept evidence that is consistent with their own ideas. (Benchmarks for Science Literacy, page 332	It is important for students to have many experiences with a concept which will provide evidence that challenges their ideas. They must reach these conclusions on their own through experiences.

Engage

What is a microbe?

1. Ask students to name different types of things that scientists study. List their answers on the board.
   Note to teacher: Student answers may include plants, animals, stars, space, chemicals, humans, and diseases.
2. Ask the students how scientists study the things that are listed on the board. Write their answers in a separate column.
   Note to teacher: Student answers may include using a microscope, magnifying glass, telescope, and going up in the space shuttle.
3. Explain to the students that some scientists specialize in studying living things.
4. Ask the students how scientists study living things. Write their answers in a third column on the board.
   Note to teacher: Students may repeat many of their answers from step 2.

5. Explain to the students that they will be conducting an investigation involving living things and will be comparing their methods with the methods NASA scientists use.
   Note to teacher: This is the goal of the lesson.

6. Ask the students to name some of the living things that they know.
   Note to teacher: All of the living things that students mention will most likely be animals and may be plants.

7. Once the students have had time to share living things that they know, show the students a mushroom or bread mold. Ask students if the example you are showing is a living thing. Have them explain the characteristics of a living thing.
   Note to teacher: The students should include in their explanation that the mushroom or bread mold requires energy and nutrients, grows, and makes more of itself. If the students struggle with this concept, refer to the activity suggested under the Prerequisite Concepts for a living thing.

8. Explain to the students that the example (mushroom or bread mold) is called a microbe. If the students have not heard of microbes before, it would be beneficial to explain that if they eat mushrooms on their pizza, they are eating microbes. If they eat yogurt, they are eating microbes because microbes turn milk into yogurt. If they leave food in the refrigerator too long, microbes will grow on it.

9. Explain that microbes are tiny living things that are too small to be seen with just the eyes.
   Note to the teacher: Students often have difficulty understanding that there are creatures so small a magnifying glass or microscope is needed to look at them.

10. Using the links provided, have students look at information on microbes. If this is not possible, check out a book on microbes from the library. It is very helpful for the students to look at images of microbes so they can begin to understand what they look like.

Links to microbe information:
- http://www.microbes.org
- http://commtechlab.msu.edu/sites/dlc-me/
- http://www.pfizer.com/rd/microbes/

Note to the teacher: Depending on time and grade level, the extra information below can be included in the lesson. However, students, do not have to understand this information for the lesson.

Interesting microbe information:
- Microbes live almost everywhere: in the soil, water, air, plants, and animals, including humans.
- Your mouth is a habitat for millions of microbes. There are also microbes in your intestines to help with digestion. There are microbes all over your body.
- In a handful of soil, there are hundreds to thousands of different types of microbes.
- Some microbes live in hot springs, volcanoes, and glaciers. Some scientists believe there could be microbes on Mars.
- There are four main types of microbes: viruses, bacteria, protists, and fungi.
  - **Viruses:** Examples are those that cause the flu, common cold, chickenpox, HIV, measles, mumps, and rabies. Scientists do not agree on whether to consider viruses as living or non-living organisms.
  - **Bacteria:** Examples are those that cause strep throat, scarlet fever, tetanus (lockjaw), Lyme disease, and meningitis. A small percentage of bacteria cause sickness. Many bacteria are helpful. For example, one type of bacteria causes milk to turn to yogurt. Another type produces an antibiotic that can be used to treat infections.
  - **Protists:** Examples are slime mold, paramecium, volvox, and euglena.
  - **Fungi:** Examples are mold, mildew, mushrooms, and yeast.

11. Discuss with the students why scientists might study microbes.
    Note to the teacher: The students may respond with such answers as to help prevent the spread of infections, to learn which microbes are harmful and which are helpful, to learn how to get rid of mildew in your shower, to learn what mushrooms can be eaten, and to learn what soaps kill bacteria on our hands.

12. Explain to students that there are scientists called astrobiologists who study life in our universe. The NASA Astrobiology Institute is interested in three fundamental questions:
    - How did life begin and evolve?
    - Is there life elsewhere in the universe?
    - What is the future for life on Earth and beyond?

    These scientists study microbes specifically to understand the extreme environments in which microbes live so that they can determine what kinds of environments to study on other planets and moons that might have life. Explain to the students that during the next month the students will get to interact with astrobiologists through webcasts, which is streaming audio and video on the web.

Nature Walk

1. Once students have a general understanding of what a microbe is, explain to them that they are going on a nature walk. On this walk, they are going to make observations about the world around them. They should focus on looking for and thinking about microbial life. If available, take magnifying glasses for students to use.

Variation: If there are no natural areas near your school, bring in samples of nature such as leaves, flowers, soil, part of a compost pile, real or preserved specimens, or bark from a tree.

2. Have students bring paper and pen/pencil on the walk so they can record their observations and any questions.

3. Before leaving, it is important to discuss with students the importance of observing nature without disturbing it.

4. The nature walk can be conducted in whatever manner is most appropriate for your students. A recommendation is to lead the students on a short walk, asking them questions as you go, and having the students point out things they observe. Next have the students divide into partners or small groups and have them choose a small area to explore in detail. This is a great time for the students to look for signs of microbial life. At this time, magnifying glasses could be passed out. The students should be encouraged to turn over logs, observe small puddles of water, look at soil, and even look at their own hands using their hand lenses.
    Note to teacher: Depending on location of the nature walk, the most common forms of microbial life will be protists swimming in the puddles of water, bacteria on the students' hands (although bacteria will not be visible with just a hand lens), and fungi, such as mushrooms. It is difficult to see most microbes without a microscope, so keep this in mind if the students have trouble finding microbes. Focus their attention on making general observations about nature, if microbial life cannot be seen.

5. After completing the nature walk, discuss with the students what they did on their walk. Make a large chart with two columns. Label the first column "What We Did" and label the second column "What Scientists Did/Would Do."
    Note to teacher: You will add to this chart throughout this lesson, so leave plenty of room. There will be a total of four sections that you can put on the chart now or as you go through the lesson: Nature Walk, Preparation for Investigation, During the Investigation, and After the Investigation.

6. Ask the students to share what methods they used when making observations and looking for microbes on their walk. Write student answers in the first column of the chart.

7. Explain to the students that over the next month they are going to be learning about what scientists do when they perform an investigation. Ask the students to predict what they think a scientist would do on a nature walk. Write their predictions in the second column of the chart.

8. Discuss the similarities and differences between the two columns.

9. Post this chart in the classroom so more can be added to it throughout the lesson.
   Note to teacher: This chart will be referred to as the "Compare/Contrast Chart" throughout the rest of the lesson.

First Webcast: Before Going into the Field

1. Before participating in the online events, have the students review the biographies (bios) of the scientists they will be talking to.
   Link to webcast bios:
   http://quest.arc.nasa.gov/astrobiology/events/fieldwork/ed.html#profiles

2. Once the students are knowledgeable about the scientists, discuss with the students the main focus for the webcast. During the first webcast, the students will learn what an astrobiologist does, more information about microbes, preparation scientists do before conducting a fieldwork investigation, as well as the materials the students will need for their investigation.

3. After students understand the main focus of the webcast, have the students work in groups of three to four to brainstorm questions for the scientists using the Chat Question Generator. Then have them decide the five best questions for their group.

4. Have the students share the questions their group developed with the class. If possible, combine questions from different groups. This will shorten the list of questions.

5. Post these questions and have the students read them. Determine the top five to ten questions that they want to ask during the webcast.
   Note to teacher: Keep the other questions handy in case there is time during the webcast for more questions to be asked.

6. Attend the first webcast on September 18.
   Note to teacher: During this webcast, students will be introduced to the materials needed to build the Winogradsky column.
   Link to webcast participation:
   http://quest.arc.nasa.gov/astrobiology/events/fieldwork/index.html#participation

Making Predictions

1. After attending the webcast, lead a discussion using the following questions:
   - Where were the scientists during the first webcast? *(Baja California, Mexico)*
   - What were they studying while they were at this location? *(microbial mats)*
   - What are microbial mats?
   - Do you think it would be interesting to study microbial mats?

   Note to teacher: Microbial mats are groups of microbes that live in layers of soil and mud. Scientists study microbial mats to understand early life forms and what environments and conditions led to their development. If you or your students would like to learn more about microbial mats, visit NASA's Astrobiology Institute Web site at http://nai.arc.nasa.gov/index.cfm?page=focus.

2. After this discussion, explain to the students that since we can not travel to Baja where the microbial mats are, we are going to grow microbes here in the classroom. Our investigation will help us understand better the scientists' work.

3. Review with the students the investigation that was discussed by the scientists. Explain to the students that older students will be doing one investigation while they will be doing a similar, but simpler investigation. Explain to the students their investigation, " Growing Microbes in a Bag".

4. List the materials for the investigation on the board. Then explain to the students the basics of the experiment.

5. Ask the students to think about what might happen when we put bread in a bag with water and sugar and leave it to sit for a long period of time.
   Note to teacher: If you choose to use potatoes instead of bread, change this to what might happen when we put a potato in a bag and leave it sit for a long period of time.

6. As a class or in small groups, record all of the predictions the students make about what might happen.
   Note to teacher: Scientists make hypotheses instead of predictions. A hypothesis is a prediction that uses reasoning or evidence to support it. A hypothesis can be developed only if the person doing the research has previous knowledge on the subject matter. This is important to explain to the students.

7. Ask the students to look at the class/group list of predictions. The students should individually choose the one they think is most likely to occur and write this prediction in their Lab Journal.

8. Have the Compare/Contrast Chart ready. Discuss with students what they have done so far to prepare for their investigation. List this information in the chart under the "Preparation for Investigation" section and "What We Did."

9. Discuss with the students what the scientists did to prepare for their investigation. List this information in the chart under "Preparation for Investigation" section and "What Scientists Did."

Explore

Second Webcast: In the Field

1. Before participating in the second webcast, have the students review the bios of the scientists they will be talking to.
   Link to webcast bios:
   http://quest.arc.nasa.gov/astrobiology/events/fieldwork/ed.html#profiles

2. Once the students are knowledgeable about the scientists, discuss with the students the main focus for the webcast. During the second webcast, the students will learn what astrobiologists do in the field, what instruments they use to gather data, and how to prepare the microbe bags.

3. After students understand the main focus of the webcast, have the students work in groups of three to four students to brainstorm questions for the scientists. Then have them decide the best five questions for their group.

4. Have the students share the questions their group developed with the class. If possible, combine questions from different groups. This will shorten the list of questions.

5. Post these questions and have the students read them. Determine the top five to ten questions that they want to ask during the webcast.
   Note to teacher: Keep the other questions handy in case there is time during the webcast for more questions to be aked.

6. Attend the second webcast on September 20.
   Note to teacher: Have the students take careful notes on how to prepare their experiment and what they will be doing over the course of the next month.
   Link to webcast participation:
   http://quest.arc.nasa.gov/astrobiology/events/fieldwork/index.html#participation

7. After the webcast, have the Compare/Contrast Chart ready. Discuss with the students what the scientists did while they were in the field. List this information in the second column of the chart. The students will record information on what they did during their experiment later in the lesson.

8. Gather the materials to make the microbe bags. This investigation could be done as a class activity or small group activity. Breaking students into groups of about three to four students would allow each student to have greater participation in the activity.

Preparing the Microbe Bags

1. Put the slice of potato or piece of bread on a counter for one hour.

2. After an hour, place the potato or bread in the plastic sandwich bag. Seal the bag.

3. For the bread, add 1 teaspoon of water and a 1/4 teaspoon of table sugar to the bag. Reseal the bag.
   Note to teacher: If potato is used, no extra materials need to be added.

4. Have students record in their Lab Journal their first observations about the bags.

5. Store the bag in a convenient place such as a drawer. The bags can also be hung in the classroom, for example on a bulletin board.

Observing and Collecting Data

1. Observe the contents every three to four days. Be sure to keep the bag closed throughout the experiment.

2. Record observations about the bag every three to four days in the Lab Journals. Have the students use magnifying glasses if available to examine the microbes through the bag. Depending on grade level, observations can be recorded in words, pictures, or both.
   Note to teacher: The most common observations will be the growth of fungus that is black, green, and brown.

3. After the students have recorded their observations in their Lab Journals, ask each group to share the changes in their bags with the class and to describe any microbes they see growing.
   Note to teacher: If time allows, have the students share observations on every day that they collect data. Having a few groups share on each of these days is great.

4. Discuss why there are differences in the changes in each bag although all the bags may have been made out of the same materials.
   Note to teacher: Include in this discussion the fact that the amounts added as well as the location of bag may affect the growth of the microbes. Discuss that one small change can have a major effect on an experiment

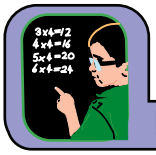
5. Once all of the data has been collected, have the Compare/Contrast Chart ready. Discuss with the students what they did during the investigation. Add this information to the section "During the Investigation" and "What We Did."

Online Forum

1. Students can post their data as well as any questions in the online forum. Astrobiologists will answer their questions.

2. Have students view data entered by other students. Discuss in small groups the similarities and differences in the data posted by other students.
   Note to teacher: Depending on grade level, consider including in the discussion the following questions: Do scientists in different parts of the world get the same data when running the same experiment? Why or why not? What do scientists do to ensure that the data they have is accurate?

3. Have a different group each week respond to a question/information posted in the online forum. Encourage the students to add their own questions to the forum.



Explain

Summary of Results

1. In small groups, have students look at all of the data obtained for their bag. Ask the students to look for major observations and changes that occurred during the last few weeks.

2. Once the students have had time to discuss the results in small groups, bring the class back together and have each group share one important observation about their bag. If multiple bags were made, remind the students that different groups will have different results. Explain that no group is wrong. Discuss what might have caused the differences.

3. Have the students write in paragraph form in their Lab Journals the most important observations and changes that occurred in their microbe bags. This activity can be done in small groups or individually. It is important to explain to the students that their paragraphs should only discuss the data and not explain why.

Variation: Instead of writing a results paragraph, students can create pictures with captions that explain the major observations and changes of the experiment.

Conclusions

1. Have students check to see if the prediction they recorded at the beginning of the experiment was close to the actual data. As a class or in small groups, discuss possible reasons for any differences between the prediction and the results.

2. Have students write a conclusion paragraph where they explain whether their prediction was or was not correct, what the results mean, and how the students think the experiment could be improved if they were to run it again.

3. Once the investigation is completed, the unopened bags can be safely included in your garbage.

Third Webcast: After the Field

1. Prepare students to attend the third webcast by reviewing the bios of the scientists.

2. Have students brainstorm questions about what the astrobiologists do when they return from the field, what data the scientists collected, how they analyzed the data, and any problems that the students had during the investigation or while writing the results and conclusions.

3. Attend the third webcast on October 25.
   Link to webcast participation:
   http://quest.arc.nasa.gov/astrobiology/events/fieldwork/index.html#participation

4. After attending the webcast, ask the students how their experiment was like the microbial mats fieldwork and how it was different.

5. Have the students review and finalize their results and conclusions. When they are finished, have the students turn in their Lab Journals to be evaluated.

6. Once the students have attended all three webcasts and turned in their lab journals, have the Compare/Contrast Chart ready. Discuss with the students what they did after the investigation. Add this information to the chart under the section "After the Investigation" and "What We Did."

7. Discuss with the students what the scientists did after the investigation. Add this information to the section "After the Investigation" and "What Scientists Did."

Extend/Apply

Design Experiment

1. Ask the students to share the basic steps they followed over the past few weeks to complete this investigation.
   Note to teacher: It would be helpful to write these steps on the board or chart paper so the students can refer back to them. These steps should include:
   1. *Develop a question;*
   2. *Make a prediction;*
   3. *List the materials;*
   4. *Write the procedures;*
   5. *Make observations/record data;*
   6. *Write the results;*
   7. *Write the conclusion.*

   Discuss with the students that some of the above steps were done for them in this investigation.

2. Once all of the basic steps have been reviewed, explain to the students that they are going to design their own experiment about a living thing, following the scientific inquiry process that was modeled/practiced in this lesson.
   Note to teacher: You may want to have all of the students design an experiment about plants, depending on time and grade level.

3. It is recommended that the students share their question before going through the rest of the steps. Some students will struggle to come up with ideas while other students will have ideas that are not possible. Explain to the students that the questions should not be yes or no questions.

4. The students should develop a question, a prediction, procedures to follow for the experiment, and a table or chart to record data. The students will not write their results or a conclusion paragraph since they are not running the experiment.

Evaluate

1. Use the Science Inquiry Evaluation Rubric to evaluate students' Lab Journals.

2. Review the student-designed experiments. Use the Science Inquiry Evaluation Rubric to evaluate the question, prediction, materials, and procedures. If the students run the experiment, their data collection, results, and conclusions can also be evaluated.

Compare/Contrast Using Venn Diagrams

1. Review the Compare/Contrast Chart with the students.

2. Have the students do one of the following activities to compare and contrast methods used in this lesson with methods used by an astrobiologist:
   - Ask the students individually or in small groups to make a Venn diagram. Have the students write "Methods used by students" in the first circle, "Methods used by astrobiologists" in the second circle, and then "Methods used by both" where the circles join. Have the students record information in each part of the Venn diagram. Then on the board or on a large piece of paper make a class Venn diagram. Have the students add one or more of their answers to the class diagram. Discuss why there are similarities and why there are differences between the methods used by the students and those used by the astrobiologists. Use the generic rubric to evaluate the individual/group work.

   OR
   - Supply each group with a large piece of paper and ask the students to make a large Venn diagram. . Have the students write "Methods used by students" in the first circle, "Methods used by astrobiologists" in the second circle, and then "Methods used by both" where the circles join. Have the students brainstorm ideas that they want to record in their diagram but instead of writing words, ask the students to draw pictures that represent the words. Use the generic rubric to evaluate their work.

   OR
   - Have the students construct a three-part book using the instructions below adapted from Dinah Zike's book, The Big Book of How to Make Projects.
     a. Fold paper or poster board like a hot dog.
     b. Holding the paper horizontally, with the fold of the hot dog up, fold the right side toward the center, trying to cover one third of the paper.
        Note: Always fold the right edge over first so the final project will open and close like a book.
     c. Fold the left side over the right side to make a book with three folds.
     d. Write the title of the project on the front of the closed book, and the student's name, the date, and any other important or required information on the back of the folded book.
     e. Open the folded book. On the inside, or the side without writing, there are two folds. Place your hands between the two thicknesses of paper and cut up the "valleys" on the side that does not have writing.
        Note: Do not cut through the cover of the project, or the side with writing. If the cuts were made correctly, three inside tabs will be formed.
     f. Draw a Venn diagram that covers the three-part book.
     g. On the first flap, write "Methods used by students." On the middle flap, write "Methods used by both." On the last flap, write "Methods used by astrobiologists."
     h. Have the students list information under each flap.
     i. Encourage the students to be neat and creative when making their three-part books.
     j. Use the generic rubric to evaluate their work.

Calendar for Growing Microbes in a Bag

- Teacher can move/change the date they do this activtiy.
  Note: Collecting data for 7 weeks is most likely not necessary. Modify the dates as needed.
- Definite dates.

	Monday	Tuesday	Wednesday	Thursday	Friday
	10 SEPTEMBER What is a Microbe?	11 Nature Walk	12 Before 1st Webcast	13 1st Webcast: Before going into the Field	14 Making Predictions First Day of Online Forum
Participate in Online Forum	17 Before 2nd Webcast	18 2nd Webcast: In the Field	19 After 2nd Webcast	20	21 Preparing Microbe Bags
	24	25 Collect Data	26	27	28 Collect Data
	1 OCTOBER	2 Collect Data	3	4	5 Collect Data
	8	9 Collect Data	10	11	12 Collect Data
	15	16 Collect Data	17	18	19 Collect Data
	22	23 Collect Data	24	25	26 Collect Data
	29	30 Collect Data	31	1 NOVEMBER	2 Collect Data
	5	6 Collect Data	7	8	9 Collect Data
	12 Results /	13 Conclusions	14 Before 3rd Webcast	15 3rd Webcast: After the Field Last Day of Online Forum	16 After 3rd Webcast
	19 Extend	20 Evaluate	21	22	23

Chat Question Generator

Name: _____

Directions:

- Read the resources of the people who will be hosting the chat found under Schedule of Events (These resources may include career fact sheets, biographies, journals, archived chats).
- List the expert's name, job title and description of what they do. (This information can be found in the resources listed for the expert on the Schedule of Events.)
- Based on the information given in the expert's resources, list at least five informed questions you would like to have answered during the chat. Your questions must comply with the following criteria:
  - the answer to the question cannot be found in the readings
  - the question cannot be answered by a simple "yes" or "no"
  - the question can be answered with a brief explanation
  - the question relates to the expert's work

Name	Job Title/Description	Questions

Growing Microbes in a Bag Lab Journal

1. Scientific Question:

2. Prediction: What is your educated guess to the question? Explain your reasoning.

4. Materials: What materials will you use to investigate?

Name:

5. Procedure: Check each step off as you complete it.

1. Put the slice of potato or piece of bread on a counter for one hour.
2. After an hour, place the potato or bread in the plastic sandwich bag. Seal the bag.
3. For the bread, add one teaspoon of water and a quarter teaspoon of table sugar to the bag. Reseal the bag. If potato is used, no extra materials need to be added.
4. Record first observations about the bags in the data collection section.
5. Store the bag in a convenient place such as a drawer. The bags can also be hung in the classroom, for example on a bulletin board.

Growing Microbes in a Bag Lab Journal

1. Scientific Question:

2. Prediction: What is your educated guess to the question? Explain your reasoning.

4. Materials: What materials will you use to investigate?

Name:

5. Procedure: Check each step off as you complete it.

Growing Microbes in a Bag Lab Journal

6. Data Collection: Record and display your data in a chart, table, picture or graph.

Name:

7. Results: Summarize the most important observations and changes that occurred during the investigation.

8. Conclusions: Was your prediction correct or not? What do the results tell you? How could the experiment be improved if you ran it again?

Scientific Inquiry Evaluation Rubric

	4 Senior Scientist	3 Junior Scientist	2 Assistant Scientist	1 Science Student
Hypothesis	• Clearly stated • Complete sentence • Explanation is detailed, logical and strongly supports prediction.	• Clearly stated • Reasonable prediction • Satisfactory explanation supports prediction.	• Reasonable prediction • Explanation doesn't show strong logic or reasoning to support the prediction.	• Lacks clarity • Hypothesis doesn't relate to the scientific question. • No explanation is given to support the prediction.
Materials	• All necessary materials are listed. • All materials are accurately described.	• All materials needed are listed. • Some are not accurately described.	• The list of materials is missing some items.	• The list of materials is not given.
Procedure	• A plan is detailed and clear. • All steps are included and in order. • Steps are detailed, complete sentences.	• A plan is needs some clarification. • Some steps are missing. • Some steps need more detail.	• A plan is satisfactory but needs clarification. • Some steps are missing or are out of order. • Some steps need more detail. • Not all steps are in complete sentences.	• A plan needs a lot of clarification. • Important steps are missing and are out of order. • Most steps need more detail. • Steps are not written in sentences.
Data Collection	• Two or more data charts, tables, diagrams or graphs are included. • Charts, tables, graphs and diagrams are accurate, complete, detailed, titled and labeled. • Recorded observations are accurate and detailed, using four to five senses.	• One data chart, table, diagram or graph is included. • Charts, tables, graphs and diagrams are accurate but lack some details. • Recorded observations are accurate but could have more detail and use only three senses.	• At least one data chart, table, diagram or graph is included. • Charts, tables, graphs and diagrams are incomplete, poorly labeled, messy, inaccurate or incorrectly labeled. • Some recorded observations are inaccurate, lack detail and use only two senses.	• No data chart, table, diagram or graph is included. • Recorded observations are inaccurate, lack detail and use only one sense.
Results	• Results are expressed clearly, accurately and in detail. • Some patterns are described well in a written summary statement.	• Data results are expressed accurately, but some further explanation is needed. • Some patterns are described well in a general summary statement. • Sentence structure needs to be clearer.	• Data results are expressed accurately, but data is too specific for a summary. • No patterns are indicated. • Results are given in incomplete sentences.	• Data results are expressed inaccurately, don't match the data and/or data is too specific for a summary. • No patterns are indicated. • Results are given in incomplete sentences.
Conclusions	• Clearly explained • Complete sentences • Explanation is detailed, logical and strongly supports differences from prediction.	• Clearly explained • Reasonable explanation supports conclusions and differences from prediction.	• Explanation lacks detail or good logic. • Some sentences are incomplete.	• Conclusion lacks clarity. • Conclusion doesn't fit with the results and data. • No explanation is given to support the conclusions. • Sentences are incomplete.

Generic Rubric

	4 You're looking to be promoted!	3 You're qualified to do your job	2 Some training might help	1 Still learning your job?
Completeness	• Complete • Extra information is given.	• Complete	• Missing one or two key parts	• Incomplete • Inadequate • Needs to be redone
Grammar/ Spelling	• Well-written, clear • Grammar and spelling are accurate.	• Grammar and spelling are acceptable.	• May have some grammar or mistakes.	• Grammar and spelling errors prevent the audience from understanding the content.
Neatness / Creativity	• Very neat and well-organized • Many creative and original ideas are included.	• Neat and organized • Some creative ideas are included.	• Neatness or organization needs improvement.	• Neatness or organization prevents the audience from understanding the content.
Content	• Accurate • In-depth	• Accurate	• Inaccurate	• Inaccurate and incomplete

Contributed by Nancy Stubbs from Rancho Del Rey Middle School in Chula Vista, California